Circuit 1
Second

26/30

ENGINEERING
Electric circuits 1
29/11/2010
90 m

التخصص والمستوى :
اسم المساق :
تاريخ الامتحان :
زمن الامتحان :

السلطة الوطنية الفلسطينية
جامعة فلسطين التقنية طولكرم"خضوري"
second exam 2010/2011

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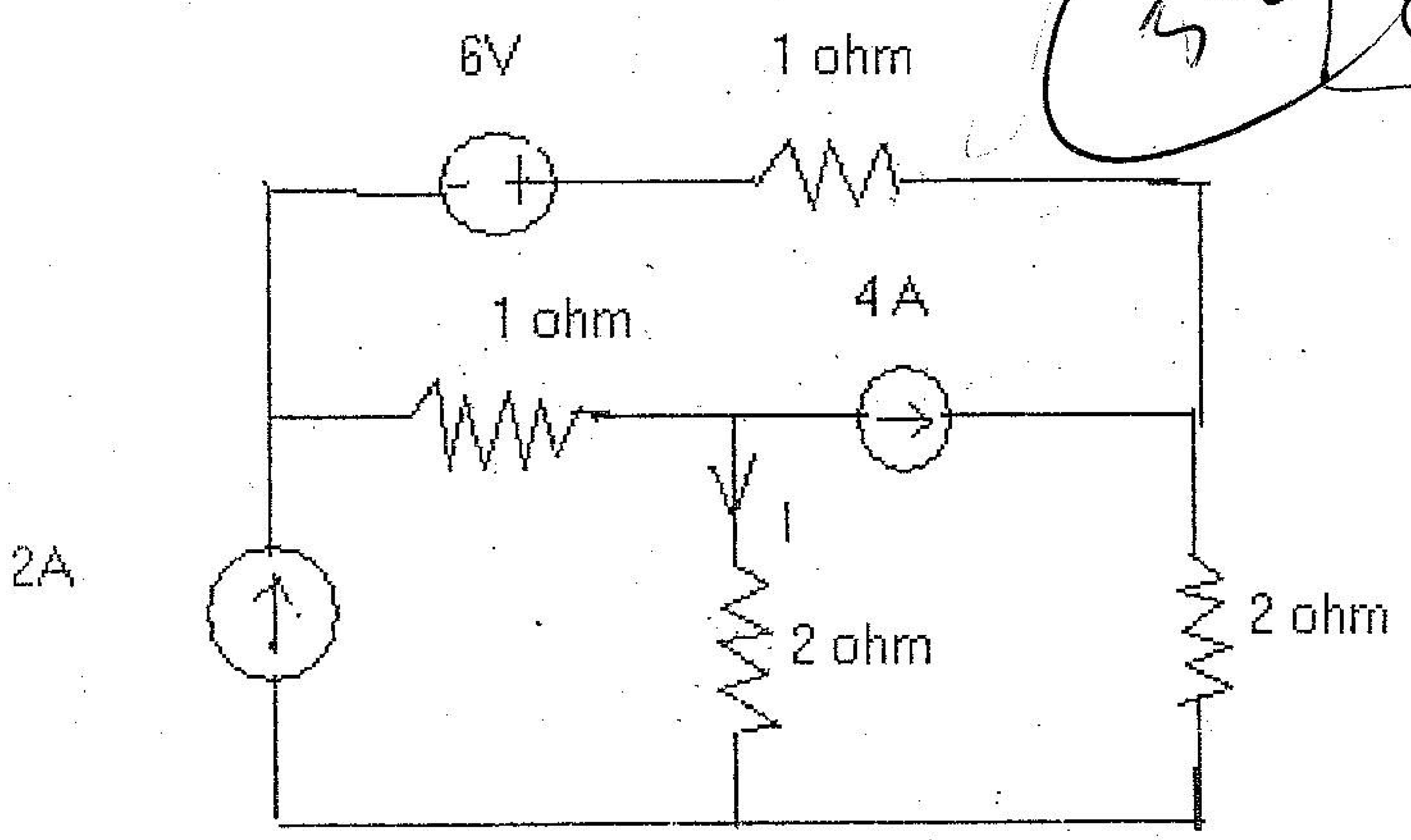
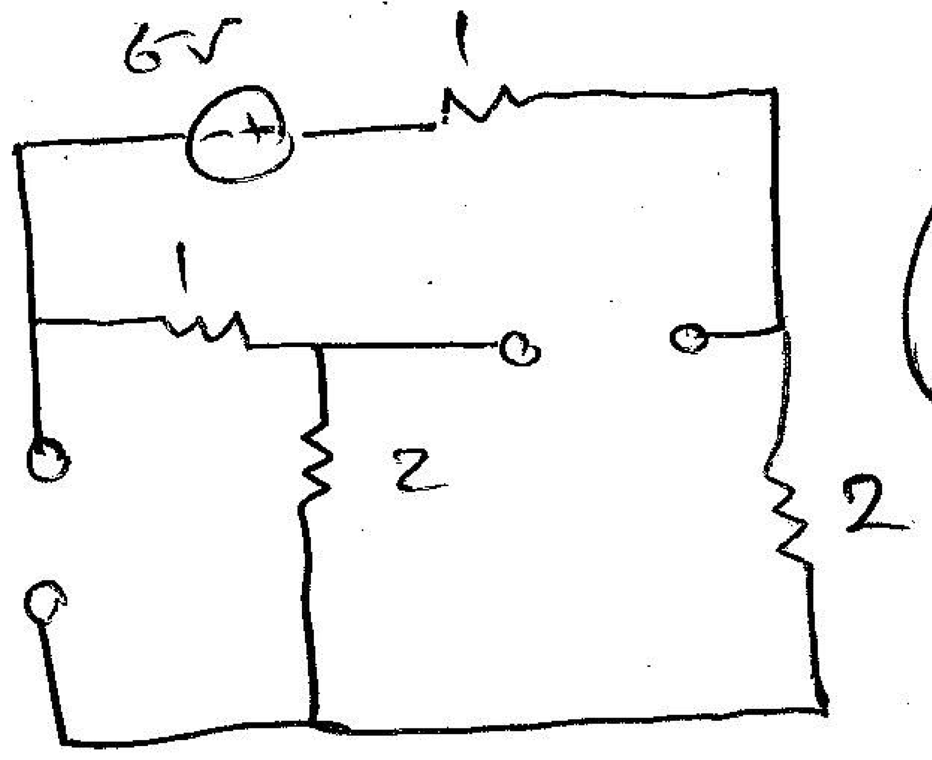
Q1) Using superposition find I in the following circuit (6 Marks)



1½

* from 6 V Source



1½

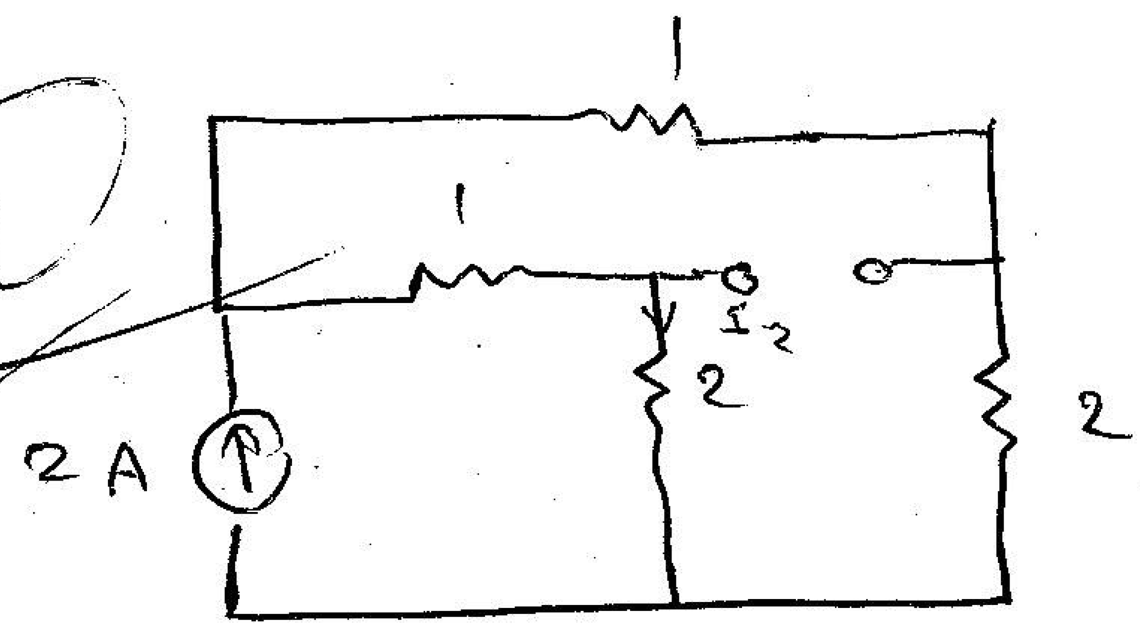
$V = IR \Rightarrow I_1 = \frac{V}{R} = \frac{6}{1+1+2+2} = \frac{6}{6} = \boxed{1A}$

* from 2 A Source

2

$I_2 = 2\left(\frac{2+1}{2+1+2+1}\right)$

$= 2\left(\frac{3}{6}\right) = \boxed{1A}$

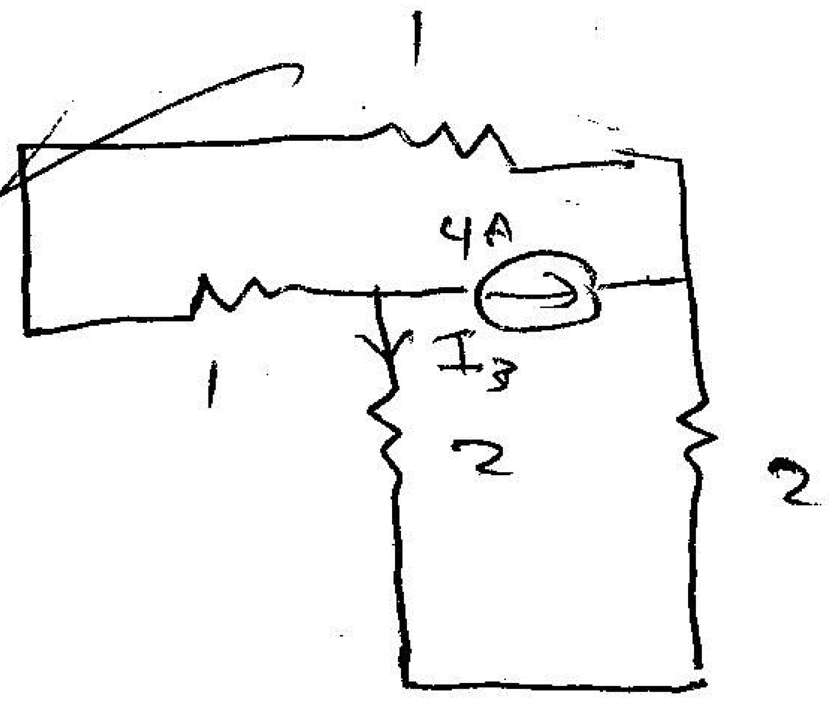


* from 4 A Source

2

$I_3 = -4\left(\frac{2}{4+2}\right) = -4\left(\frac{2}{6}\right)$

$= \frac{-8}{6} = \boxed{-1.33 A}$

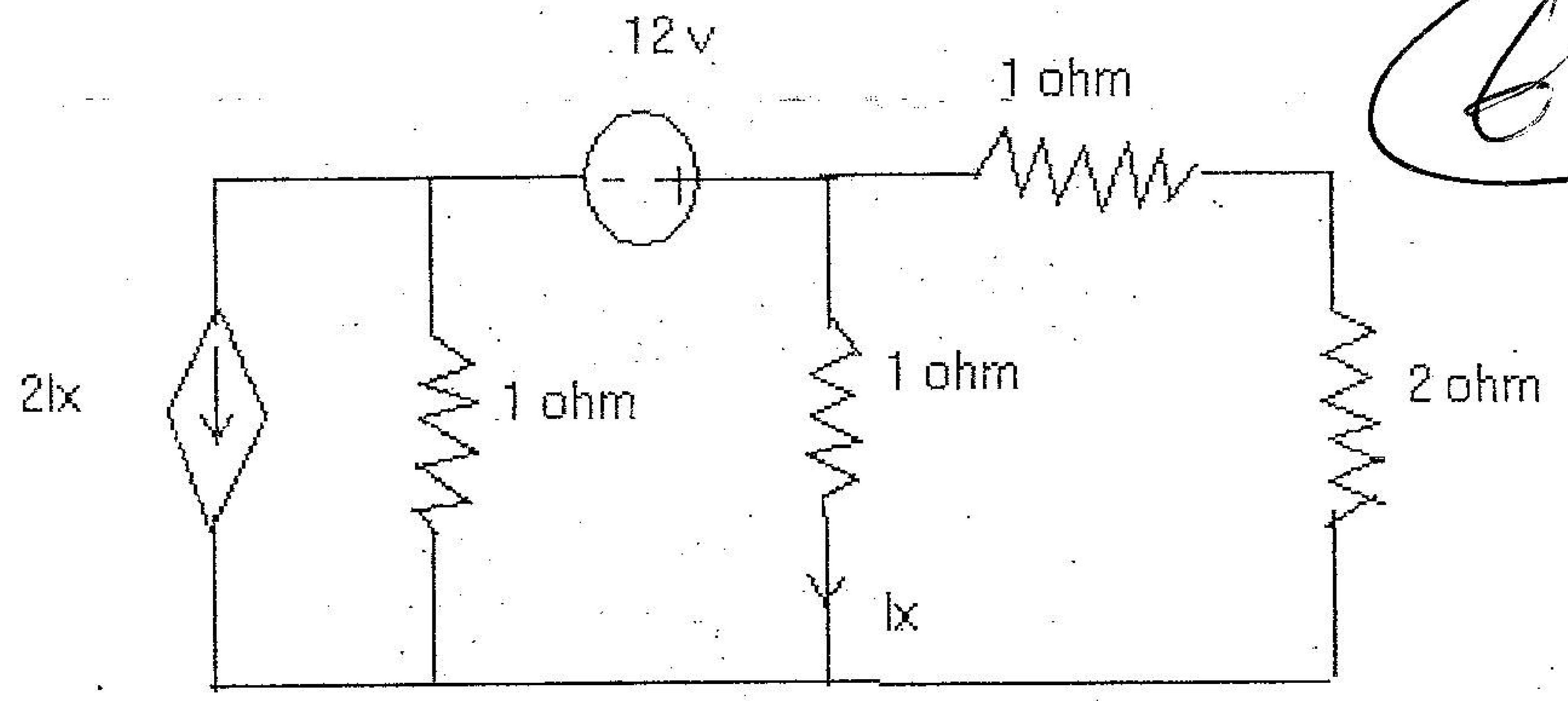


$\therefore I_{tot} = I_1 + I_2 + I_3 = 1 + 1 - 1.33$

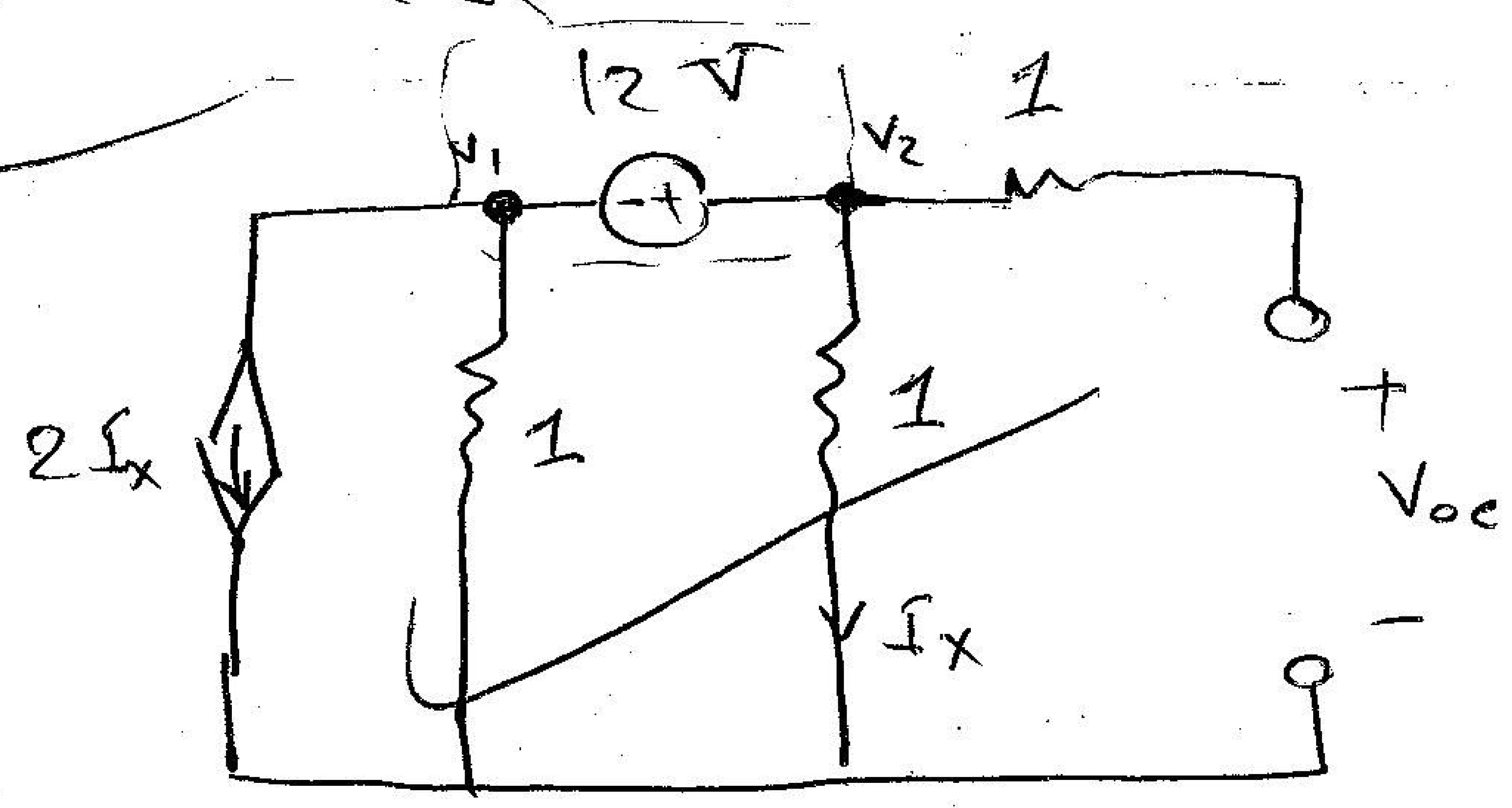
$= \boxed{0.67 A}$

تم الرفع بواسطة م. معن ابو عيسى

Q2) Using Thevenin theorem find the power of the 2-Ω resistor Super Node (6 marks)



6



* To find V_{TH}, Remove the Load and find $\underline{V_{oc}}$

Using Nodal Analysis :-

we have a super Node here

$I_x = \frac{V_2}{1}$

* ∴ $\frac{V_1}{1} + 2I_x + \frac{V_2}{1} = 0$

∴ $\frac{V_1}{1} + 2V_2 + V_2 = 0 \Rightarrow V_1 + 3V_2 = 0$ —— ①

* From super Node $\Rightarrow V_2 - V_1 = 12$ —— ②

3

$\boxed{V_2 = 12 + V_1}$

∴ $V_1 + 3(12 + V_1) = 0 \Rightarrow V_1 + 36 + 3V_1 = 0$

$4V_1 + 36 = 0 \Rightarrow \Rightarrow V_1 = \frac{-36}{4} = \boxed{-9\ V}$

$V_2 - V_1 = 12 \Rightarrow V_2 - -9 = 12$

$V_2 + 9 = 12 \Rightarrow V_2 = \boxed{3\ V}$

$\boxed{∴ V_2 = V_{oc} = V_{TH} = 3\ V}$

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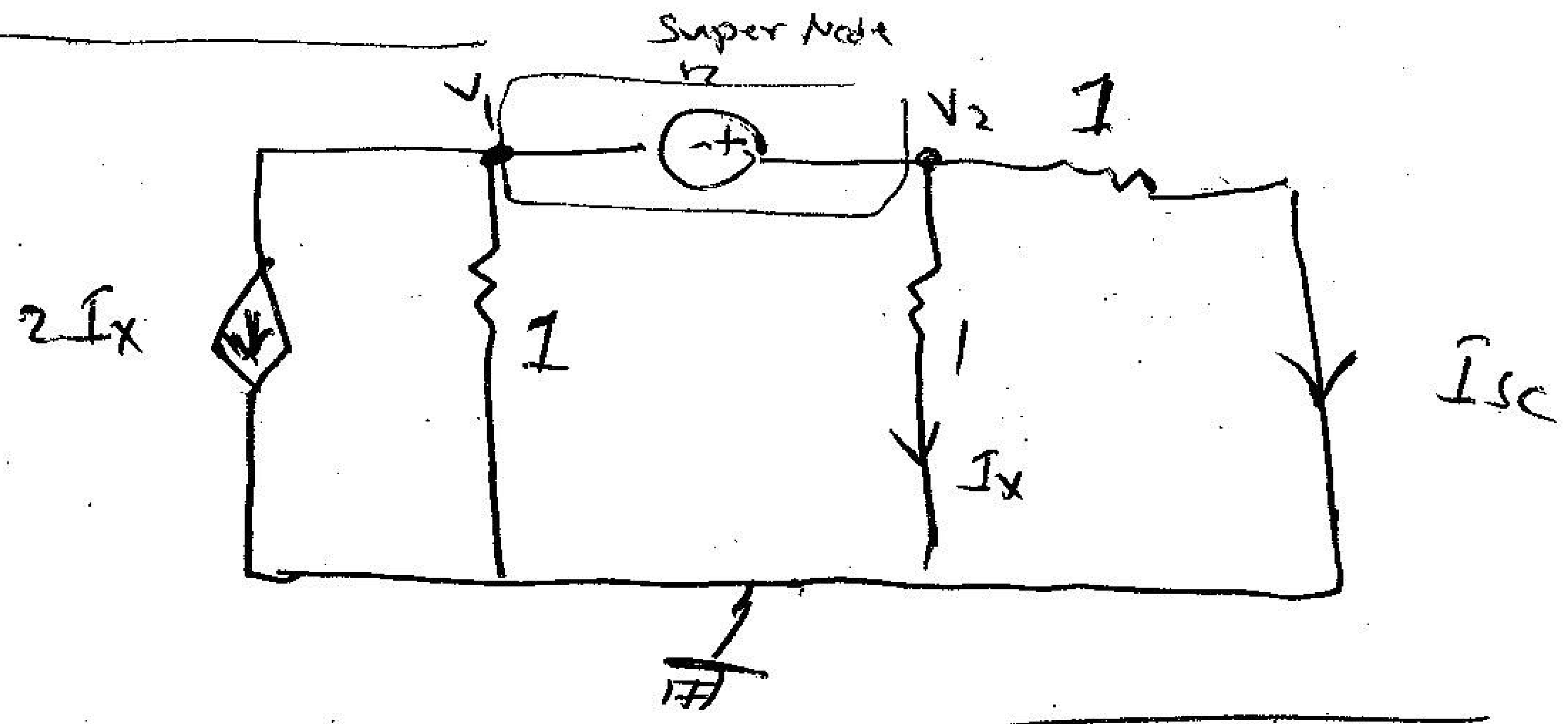
* To find R_{TH}

Using Nodal



∴ $\frac{V_1}{1} + 2I_x + \frac{V_2}{1} + \frac{V_2}{1} = 0$

$V_1 + 2V_2 + V_2 + V_2 = 0$

$V_1 + 4V_2 = 0$ —— ①

$V_2 - V_1 = 12 \Rightarrow \boxed{V_2 = 12 + V_1}$ —— ②

∴ $V_1 + 4(12 + V_1) = 0 \Rightarrow V_1 + 48 + 4V_1 = 0$

$\Rightarrow 5V_1 + 48 = 0 \Rightarrow V_1 = \frac{-48}{5} = \boxed{-9.6\ V}$

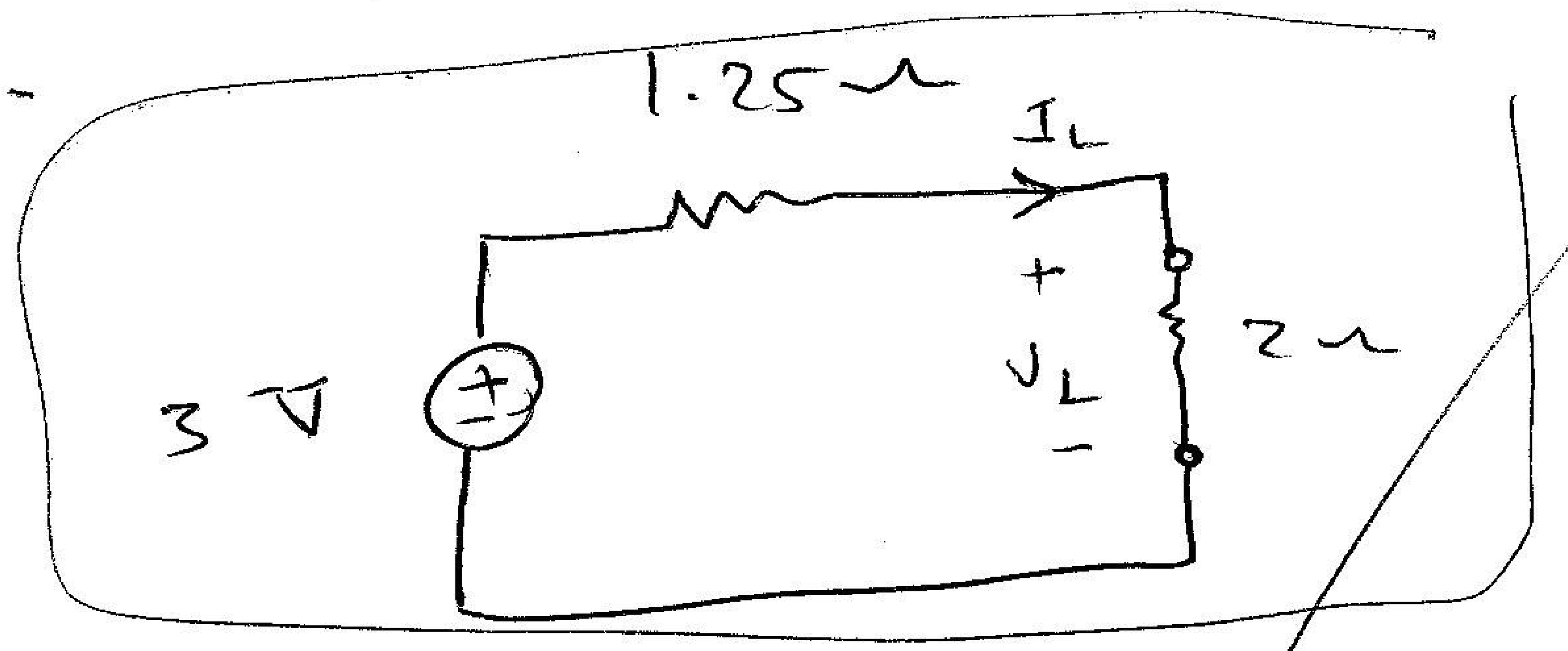
خلف الصفحة

$V_2 = 12 + V_1 = 12 - 9.6 = \boxed{2.4\ V}$

$\therefore I_{sc} = \frac{V_2}{1} = \boxed{2.4\ A}$

$\therefore R_{TH} = \frac{V_{oc}}{I_{sc}} = \frac{3}{2.4} = \boxed{1.25\ \Omega}$

$\therefore$



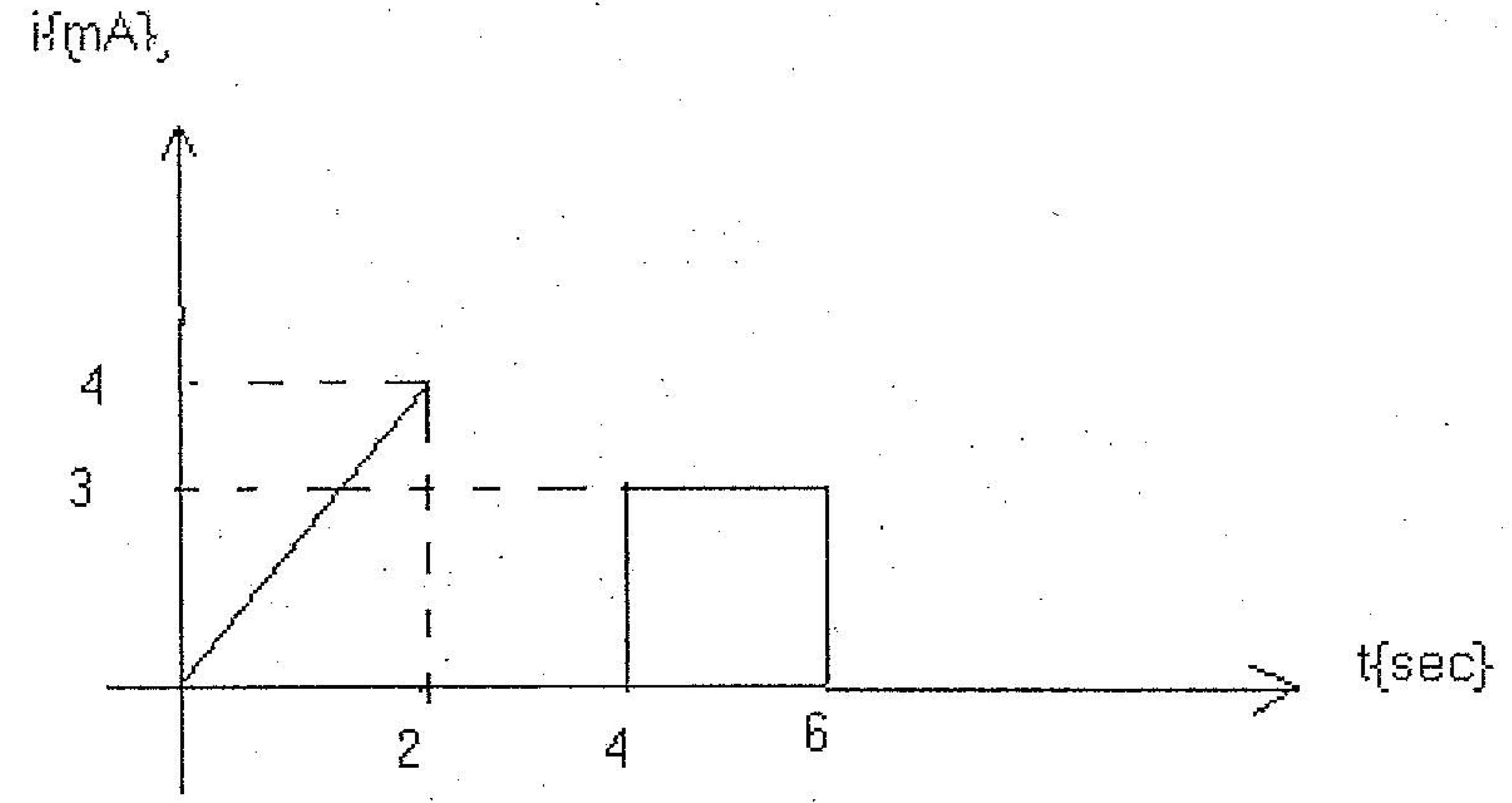
Thevenin Equivalent Circuit

$P_{2\Omega} = \frac{V^2}{R} \Rightarrow V_{2\Omega} = 3\left(\frac{2}{2+1.25}\right) = 3\left(\frac{2}{3.25}\right) = \boxed{1.85\ V}$

$\therefore P_{2\Omega} = \frac{V^2}{R} = \frac{(1.85)^2}{2} = \boxed{1.71\ W}$

Q3) An initially uncharged 1-mf capacitor has the current shown in the fig. Find and draw the capacitor voltage. What is the energy stored in the capacitor at t=1 s & at t=5 s (6 marks)

6



$\frac{4-0}{2-0} = \boxed{2t}$

$\boxed{i_c(t) = \boxed{2t} \quad (0<t<2\ \text{sec})}$

$V_c(t) = V_c(t_0) + \frac{1}{C}\int_{t_0}^{t} i_c(t)\,dt$

$\boxed{V_c(0) = 0}$

$\boxed{0 < t < 2\ \text{sec}}$

$V_c(t) = V_c(0) + \frac{1}{C}\int_{t_0}^{t} i_c(t)\,dt = 0 + \frac{1}{1\times10^{-3}}\int_0^t 2t\,dt \times 10^{-3}$

$= \left(\frac{2t^2}{2}\right)\Big|_0^t = \boxed{t^2}$

$V_c(2) = (2)^2 = \boxed{4\,V}$

$\boxed{2 < t < 4\ \text{sec}}$

$V_c(t) = V_c(2) + \frac{1}{C}\int_{t_0}^{t} i_c(t)\,dt = 4 + \frac{1}{1\times10^{-3}}\int_2^t 0\,dt \times 10^{-3} = \boxed{4\,V}$

$V_c(4) = \boxed{4\ \text{Volts}}$

$\boxed{4 < t < 6\ \text{sec}}$

$V_c(t) = V_c(4) + \frac{1}{C}\int_4^t i_c(t)\,dt = 4 + \frac{1}{1\times10^{-3}}\int_4^t 3\,dt \times 10^{-3} = 3t\Big|_4^t$

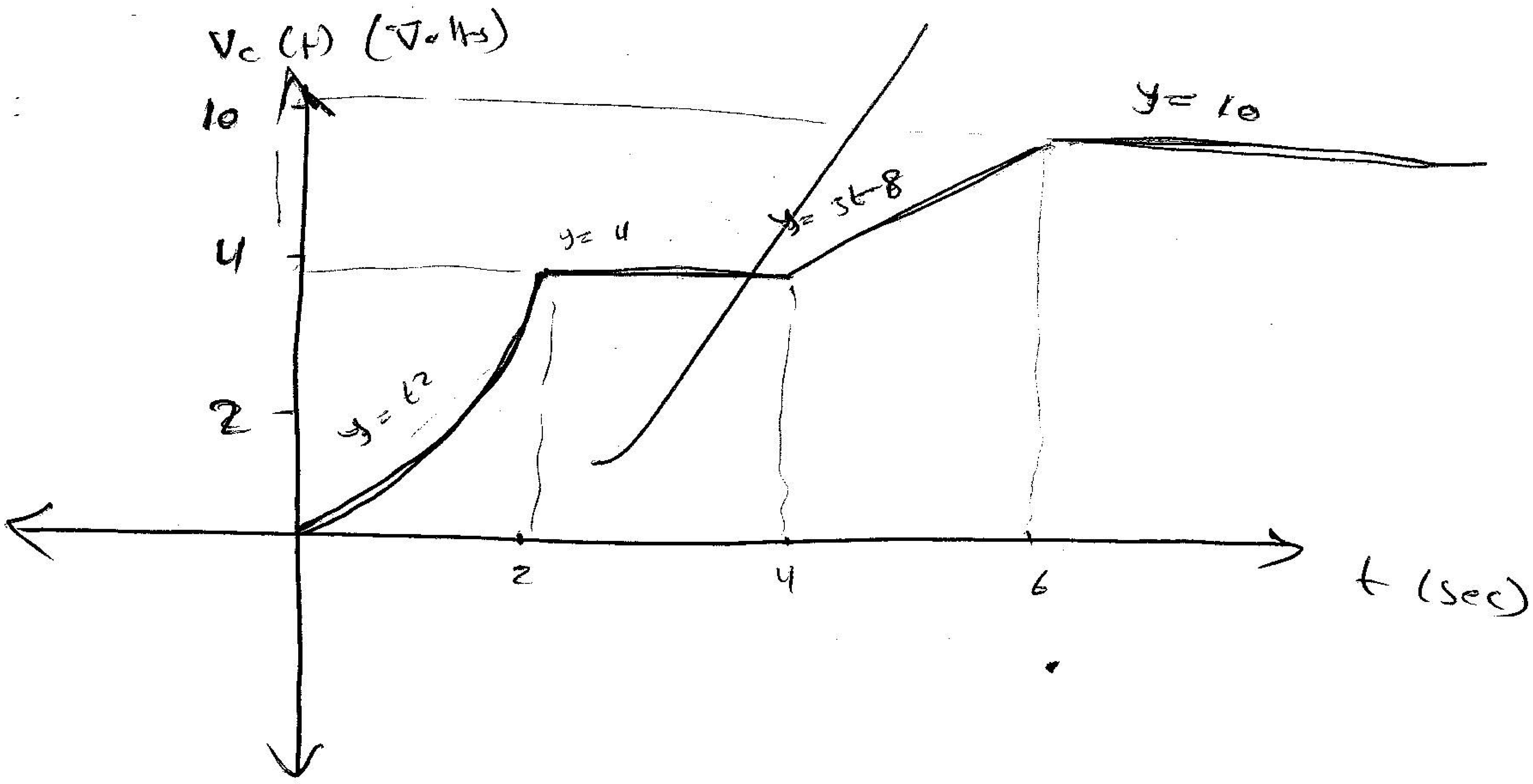
$= 4 + 3t - 12$

$= \boxed{3t - 8}$

$V_c(6) = 3(6) - 8 = 18 - 8 = \boxed{10\,V}$

$\boxed{t > 6\ \text{sec}}$ $V_c(t) = 10 + \int_6^t 0 \times 10^{-3}\,dt = \boxed{10\,V}$

خلف الصفحة



$$W(1s) = \frac{1}{2} C (V_c(1))^2$$

$$V_c(1) = (1)^2 = \boxed{1}$$

$$\therefore W(1s) = \frac{1}{2} \times 1 \times 10^{-3} \times (1)^2 = \frac{1}{2} \times 10^{-3}$$

$$= 0.5 \times 10^{-3} \; W$$

$$= \boxed{0.5 \; mW}$$

$$W(5s) = \frac{1}{2} C (V_c(5))^2$$

$$V_c(5) = 3(5) - 8 = 15 - 8 = \boxed{7}$$

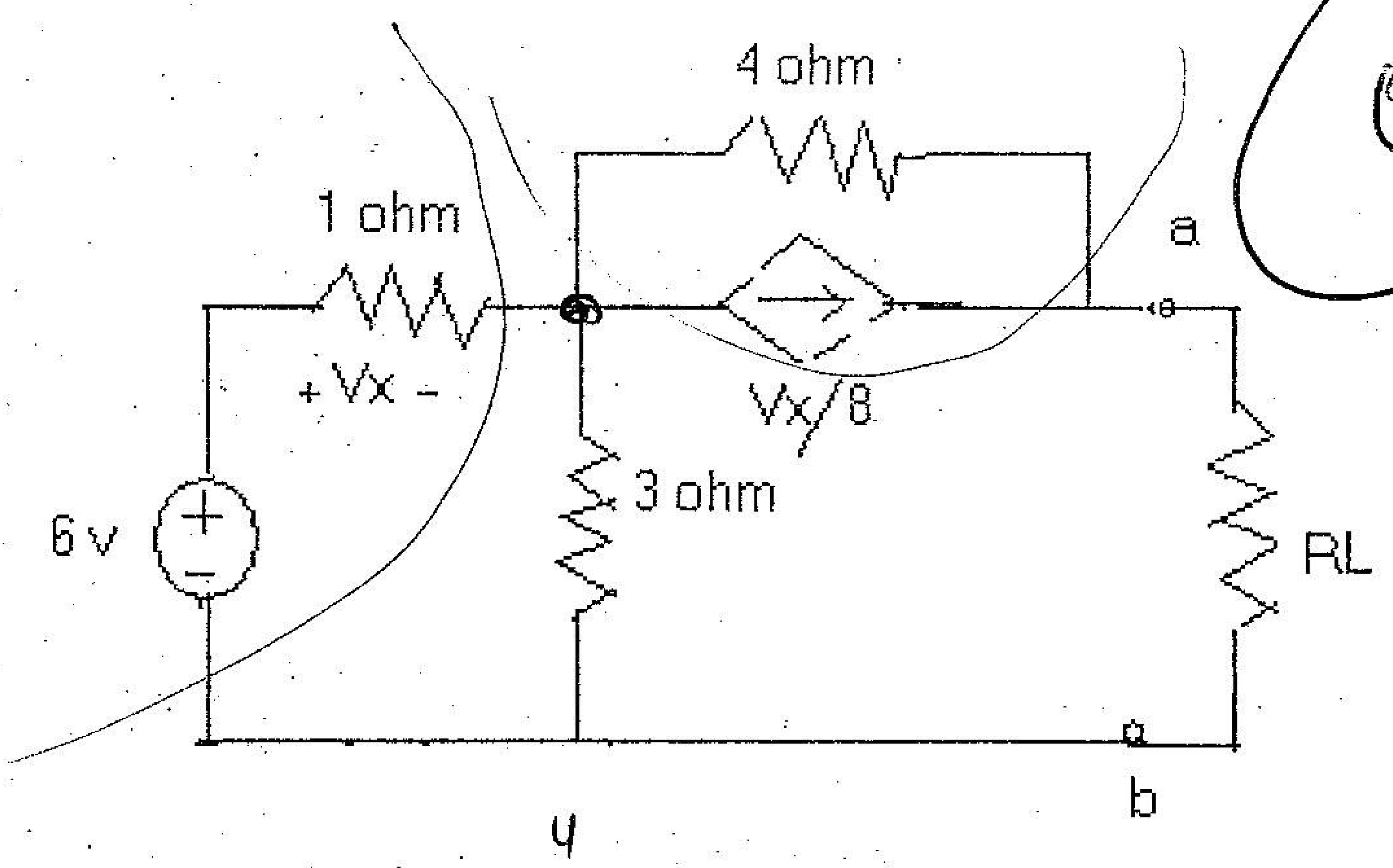
$$\therefore W(5s) = \frac{1}{2} C (7)^2 = \frac{1}{2} \times 1 \times 10^{-3} \times 49$$

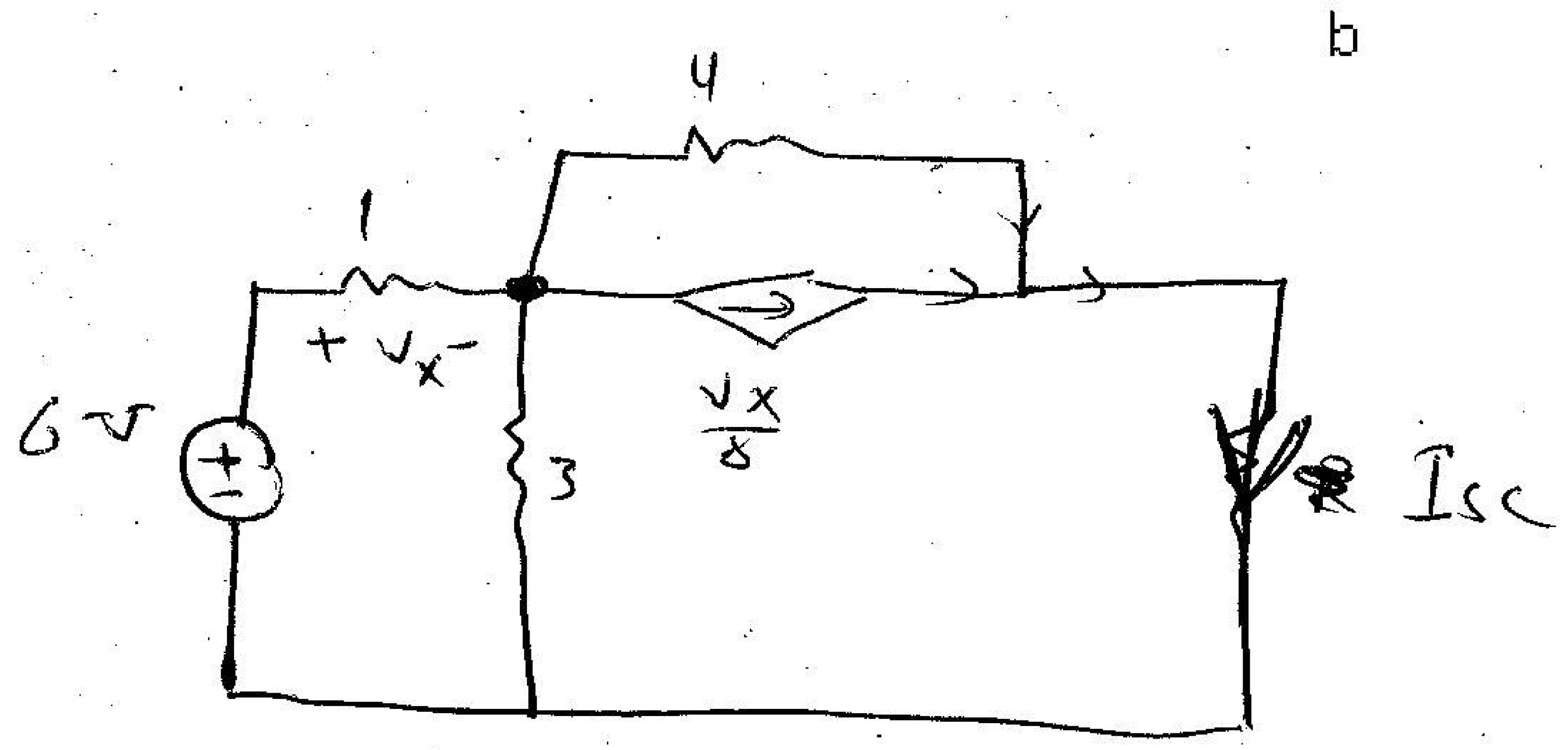
$$= 24.5 \times 10^{-3}$$

$$= \boxed{24.5 \; mW}$$

Q4)In the circuit below find the Norton equivalent between a&b. What is the value of RL for maximum power transfer . Find the maximum power transferred to the load. (6 marks)

0





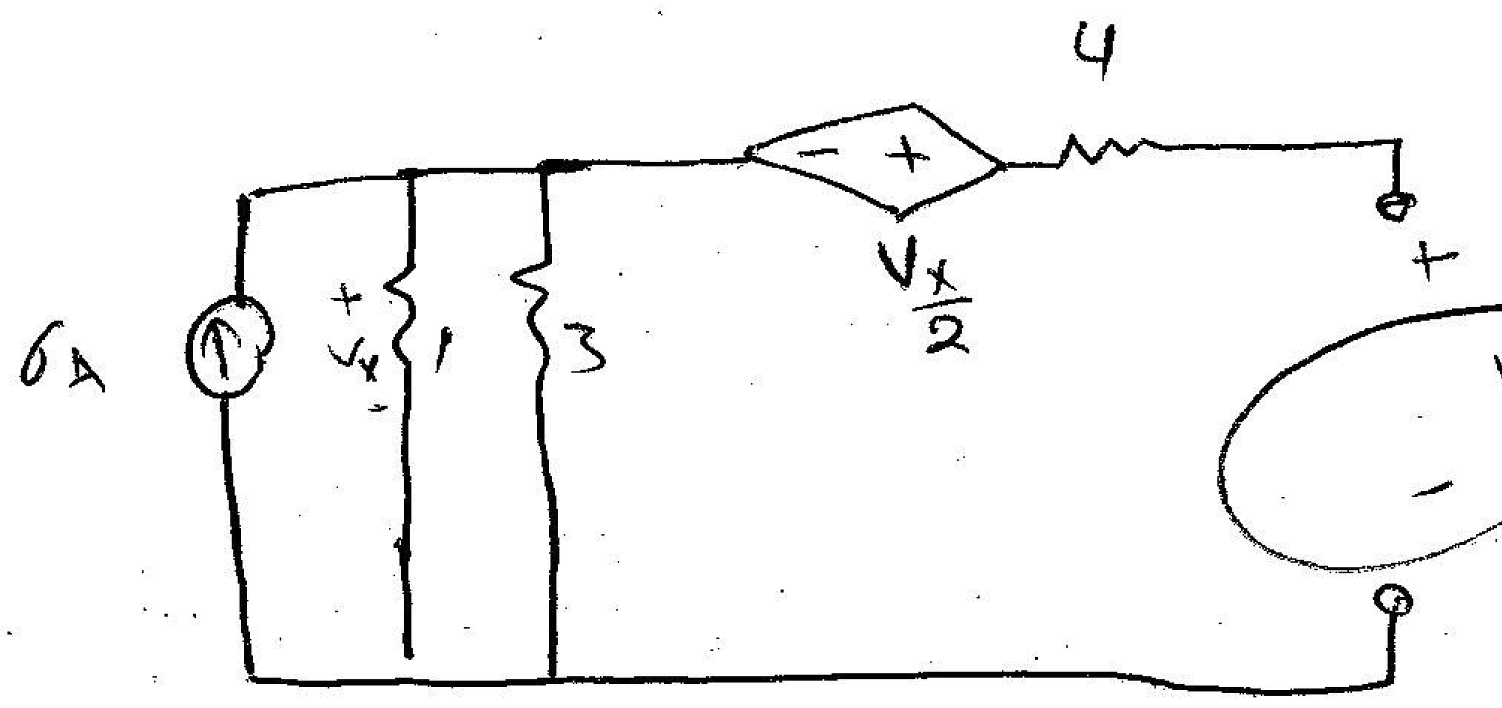
⊛ find Isc

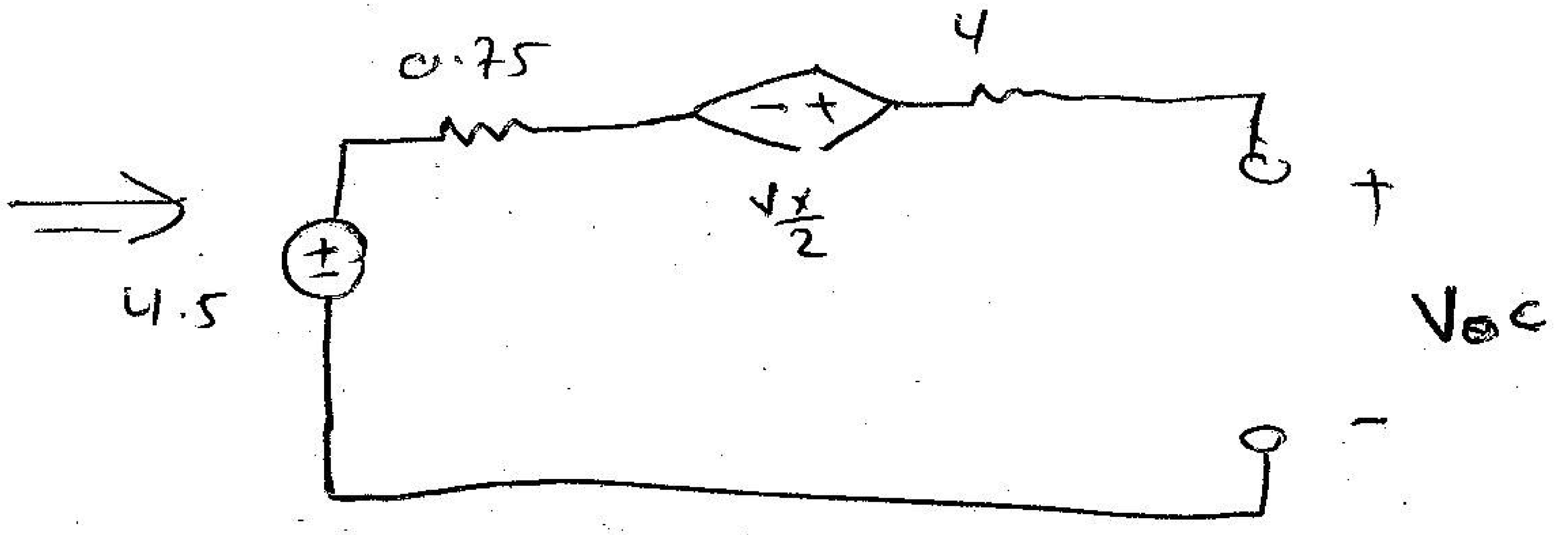
$$I_{sc} = \frac{6}{4} + \frac{V_x}{8} \qquad V_x = 6\,V$$

$$\therefore I_{sc} = \frac{6}{4} + \frac{6}{8} = 1.5 + 0.75 = \boxed{2.25\,A}$$

⊛ To find Voc (using Transformation) :-

$$\boxed{1 // 3 = \frac{1\times 3}{1+3} = \frac{3}{4} = 0.75}$$





$$4I + \frac{V_x}{2} + 0.75I + 4.5 - V_{oc} = 0$$

$$V_{oc} = 4(6) + \frac{6}{2} + 0.75(6) + 4.5$$

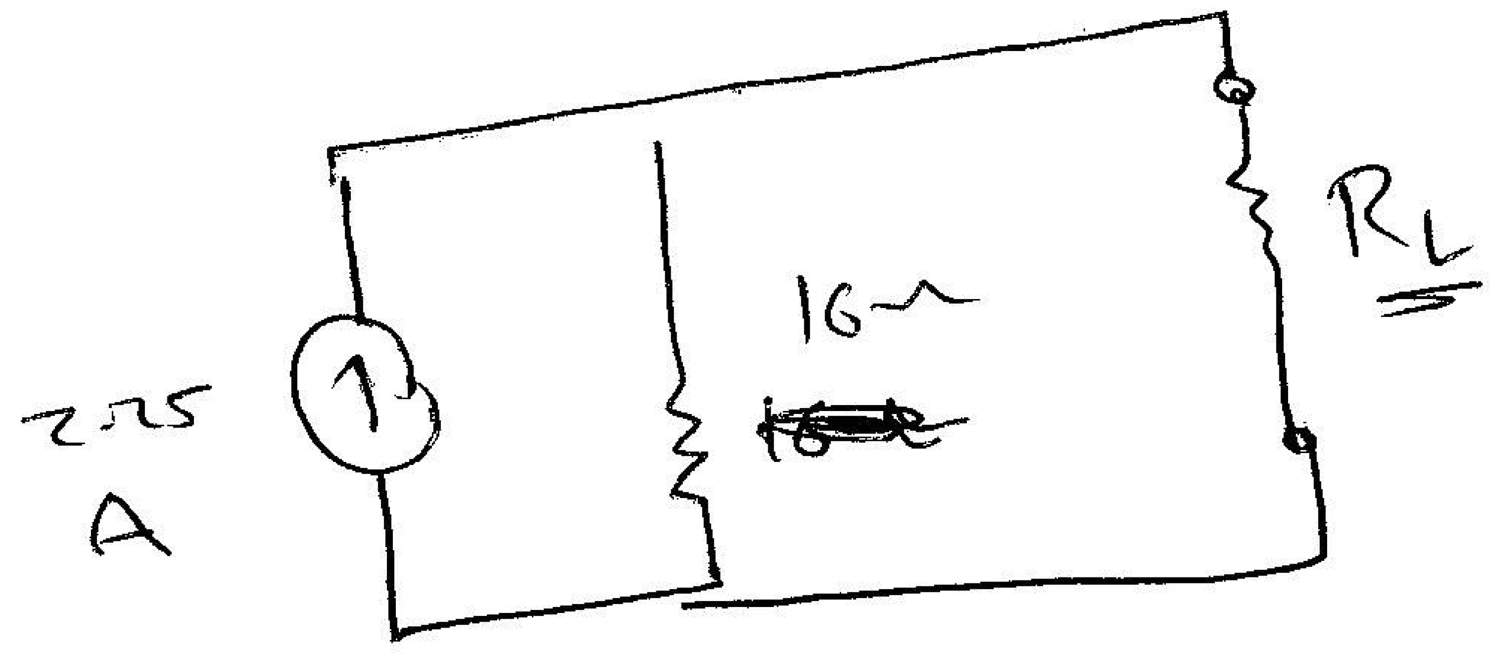
$$= 24 + 3 + 4.5 + 4.5$$

$$= \boxed{36\,V}$$

$$\therefore R_N = \frac{V_{oc}}{I_{sc}} = \frac{36}{2.25} = \boxed{16\,\Omega}$$

[illegible]

Norton Equivalent Circuit



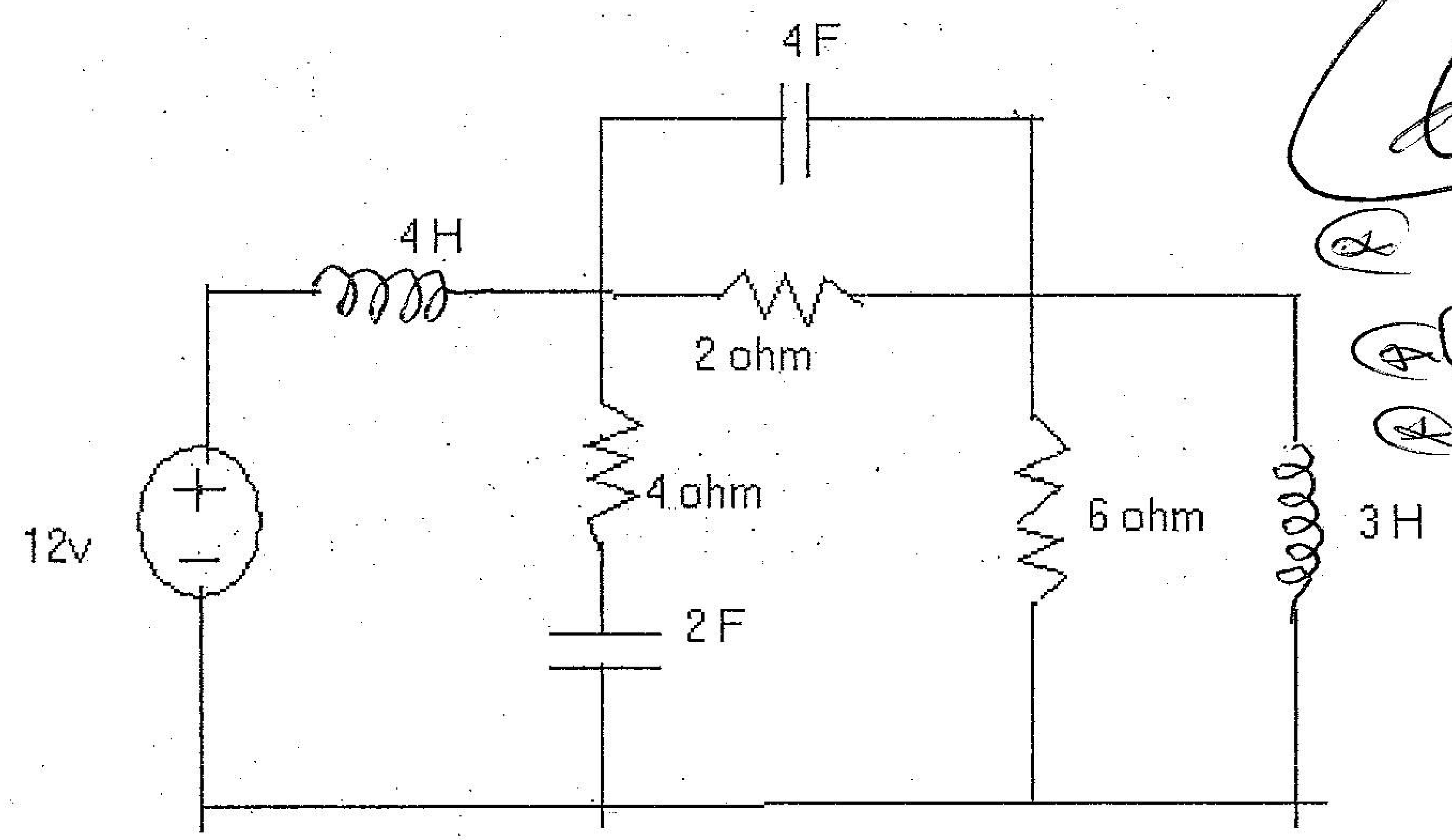
The value of R_L for maximum Power Transfer

$$\boxed{\begin{aligned} R_L &= R_S \\ \therefore R_L &= 16\,\Omega \end{aligned}}$$

$$P_{max} = \frac{V_{oc}^2}{4R_L} = \frac{(36)^2}{4(16)} = \frac{1296}{64} = \boxed{20.25\text{ W}}$$

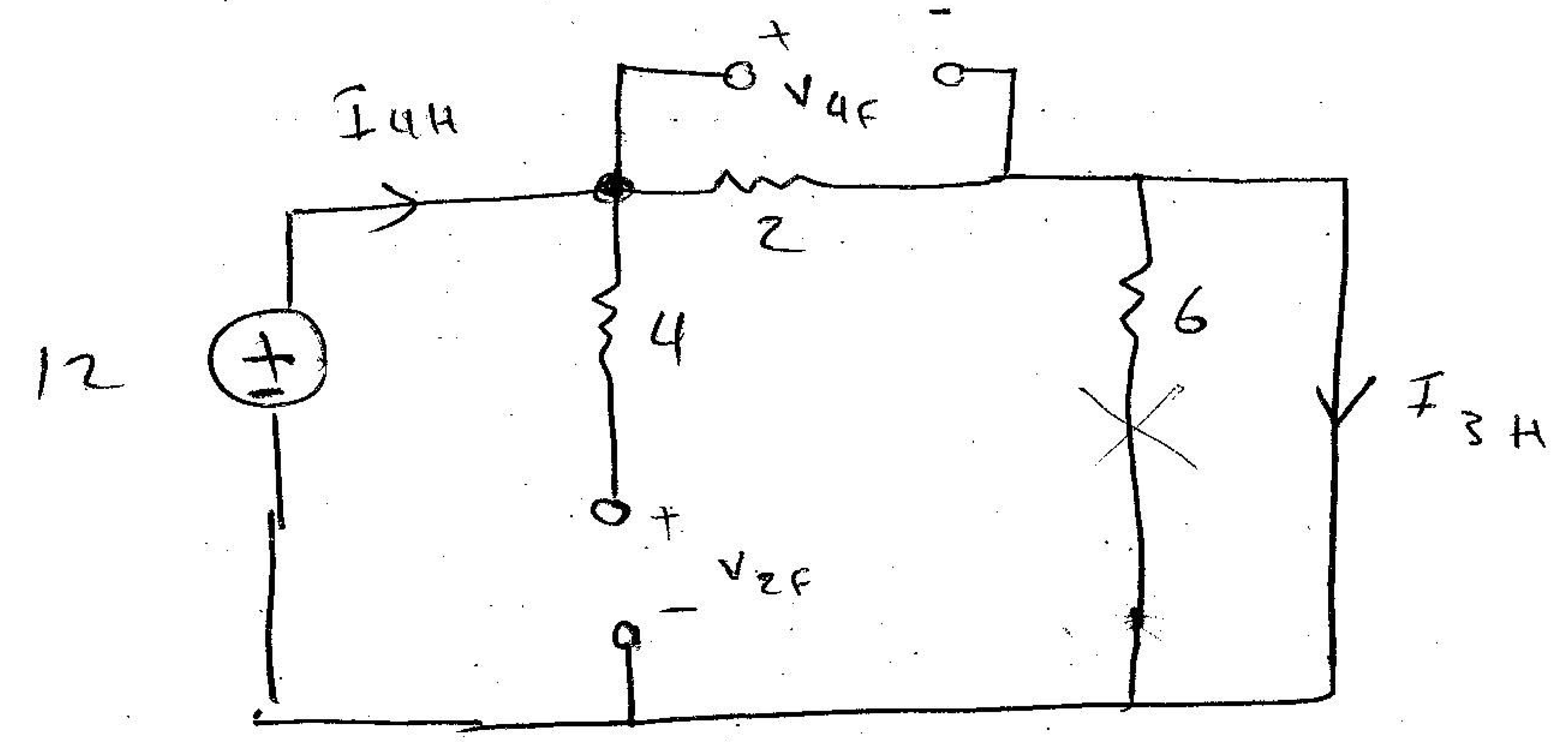
Q5)The circuit below is under dc conditions , Find the energy stored in each capacitor and inductor (6 marks)

6



* Under dc condition
* Capacitor is open circuit
* Inductor is short circuit

Important



~~$V_{2F} = V_s = 12V$~~

* $I_{tot} = I_{4H} = \frac{12}{2} = 6A \Rightarrow \boxed{W(4H)} = \frac{1}{2} L i^2 = \frac{1}{2} \times 4 \times (6)^2 = \frac{1}{2} \times 4 \times 36 = \boxed{72\ W}$

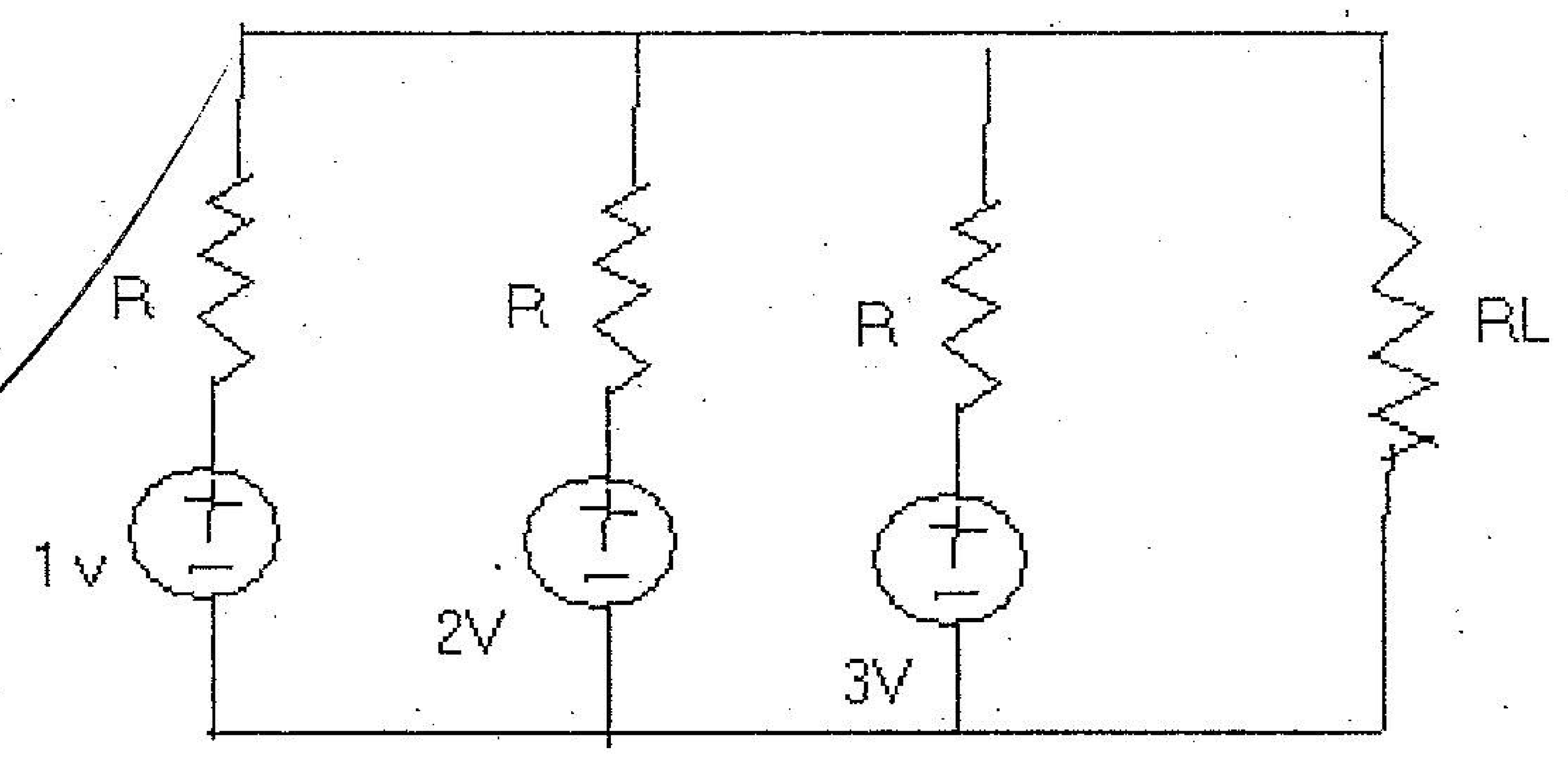
* $V_{2F} = V_s = 12\ Volts \Rightarrow W(2F) = \frac{1}{2} C V^2 = \frac{1}{2} \times 2 \times (12)^2 = \boxed{144\ W}$

* ~~V_{4F}~~ $I_{3H} = I = \frac{12}{2} = 6A \Rightarrow W(3H) = \frac{1}{2} L i^2 = \frac{1}{2} \times 3 \times (36) = \boxed{54\ W}$

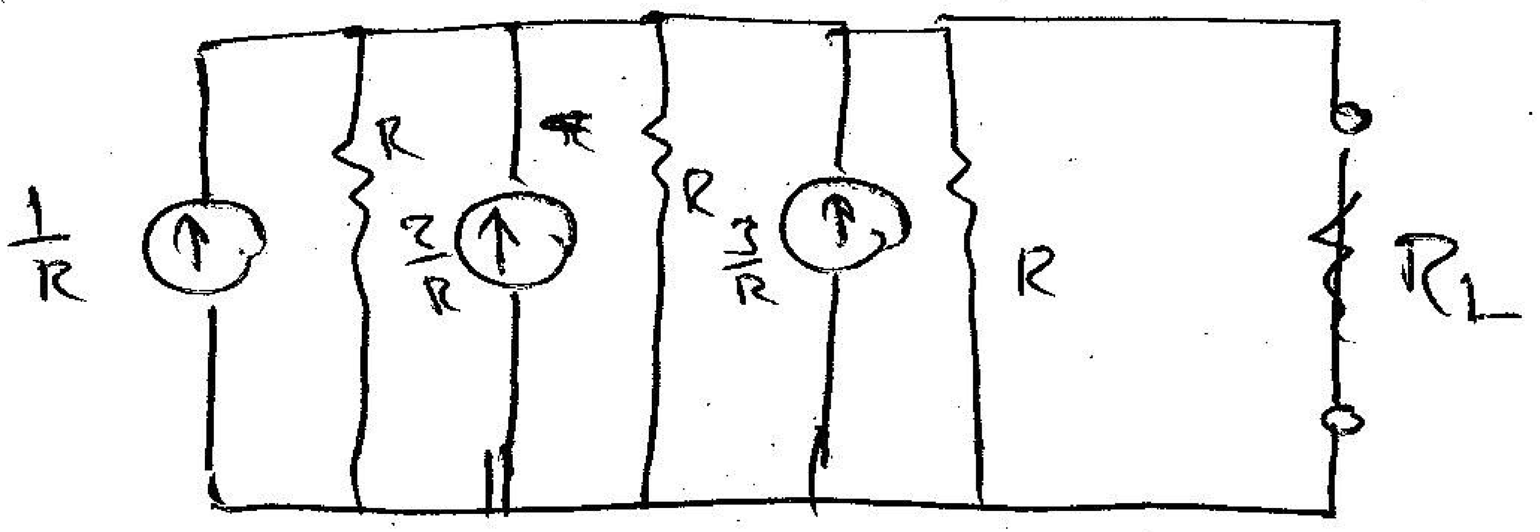
* $V_{4F} = V_{2\Omega} = \boxed{12V} \Rightarrow W(4F) = \frac{1}{2} C V^2 = \frac{1}{2} \times 4 \times (12)^2 = \boxed{288\ W}$

Note : This question is Bonus if you solve it you take more marks

Q6)In the circuit below the maximum power transferred to the load is 2 m W Find the value of R (3marks)

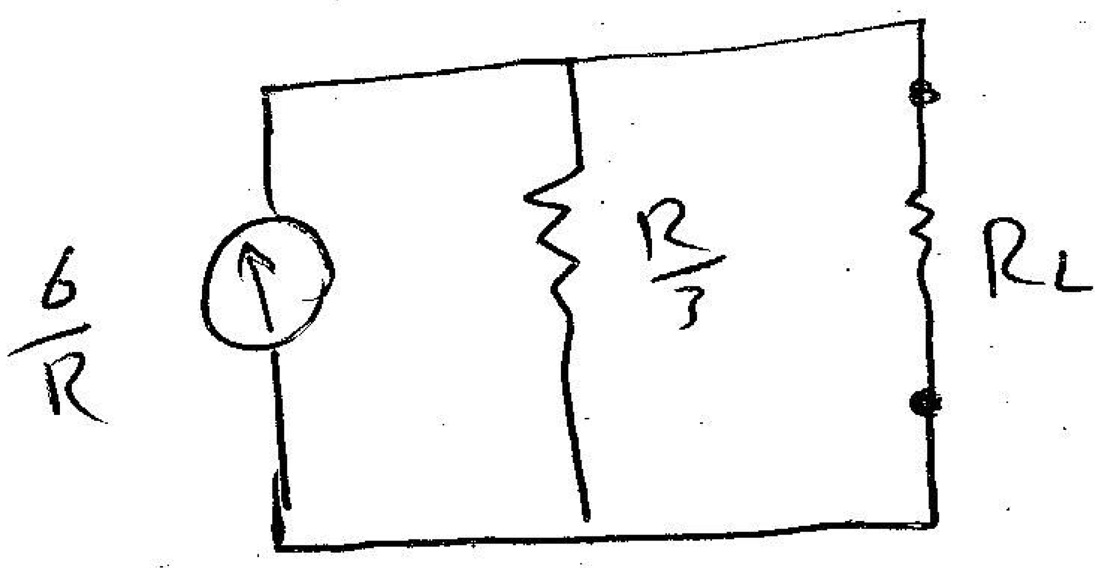


2



$$\boxed{\frac{1}{R}+\frac{2}{R}+\frac{3}{R}=\boxed{\frac{6}{R}}}$$

⇓



$$\boxed{\frac{1}{R_{eq}}=\frac{1}{R}+\frac{1}{R}+\frac{1}{R}=\frac{3}{R} \quad \therefore R_{eq}=\boxed{\frac{R}{3}}}$$

(*) $V = IR = \frac{6}{R}\left(\frac{R}{3}\right) = \frac{6}{3} = \boxed{2\,V}$

(*) $P_{R_L} = \frac{V^2}{R_L} \Rightarrow 2\times10^{-3} = \frac{4}{R_L}$

(*) $\Rightarrow R_L = \frac{4}{2\times10^{-3}} = 2\times10^{3} = \boxed{2\,k\Omega}$

(*) $\because$ for maximum Power Transfer $\Rightarrow R_L = R_s = \boxed{2\,k\Omega}$

$\therefore \frac{R}{3} = 2\,k\Omega \Rightarrow \boxed{R = 6\,k\Omega}$

$\Rightarrow \therefore \boxed{R = 6\,k\Omega}$

Good Luck
Mahmoud Ahmad